The Utica-Point Pleasant Shale Play of Ohio

Larry Wickstrom, Chris Perry,
Ron Riley, and Matthew Erenpreiss

Ohio Department of Natural Resources
Division of Geological Survey

O.D.N.R. GEOLOGICAL SURVEY
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1837–2012

OHIO DEPARTMENT OF NATURAL RESOURCES

Ohio Oil & Gas Fields

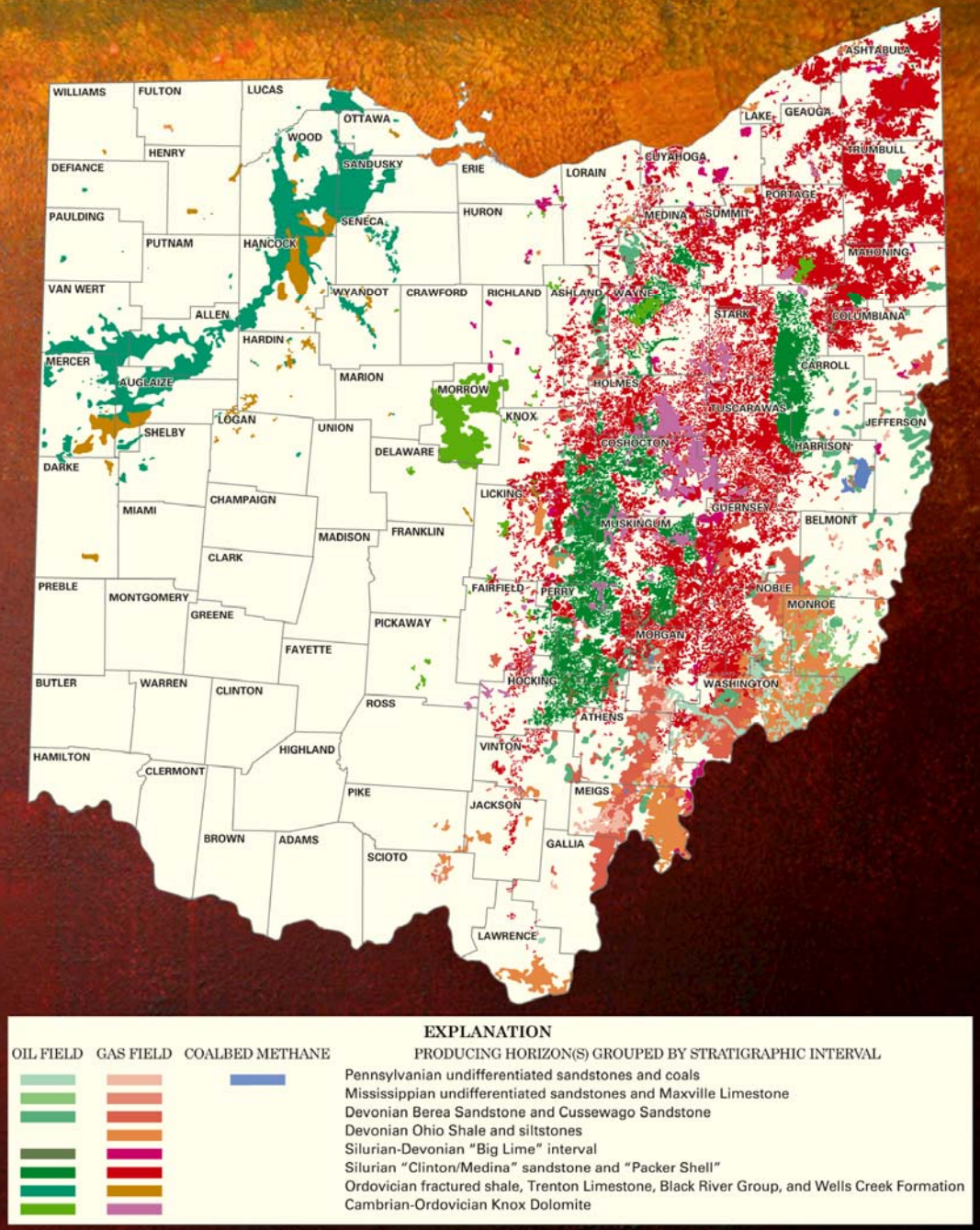
Oil & gas is not new to Ohio.

Ohio currently has in excess of 64,000 producing oil & gas wells.

Production has been established in at least 70 of 88 counties.

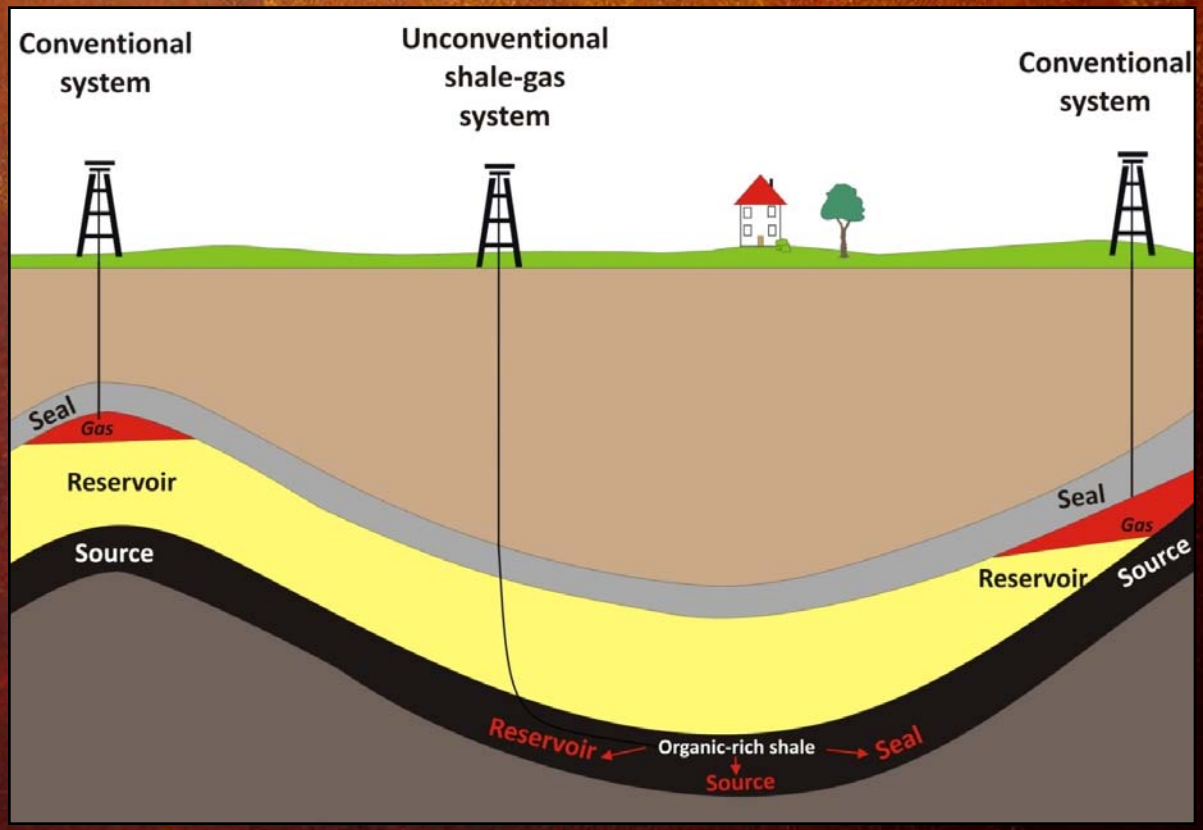
Historically, over 250,000 wells have been drilled.

Lima-Indiana Trend of NW Ohio was one of the first true giant fields produced in the U.S. (1884-1934).



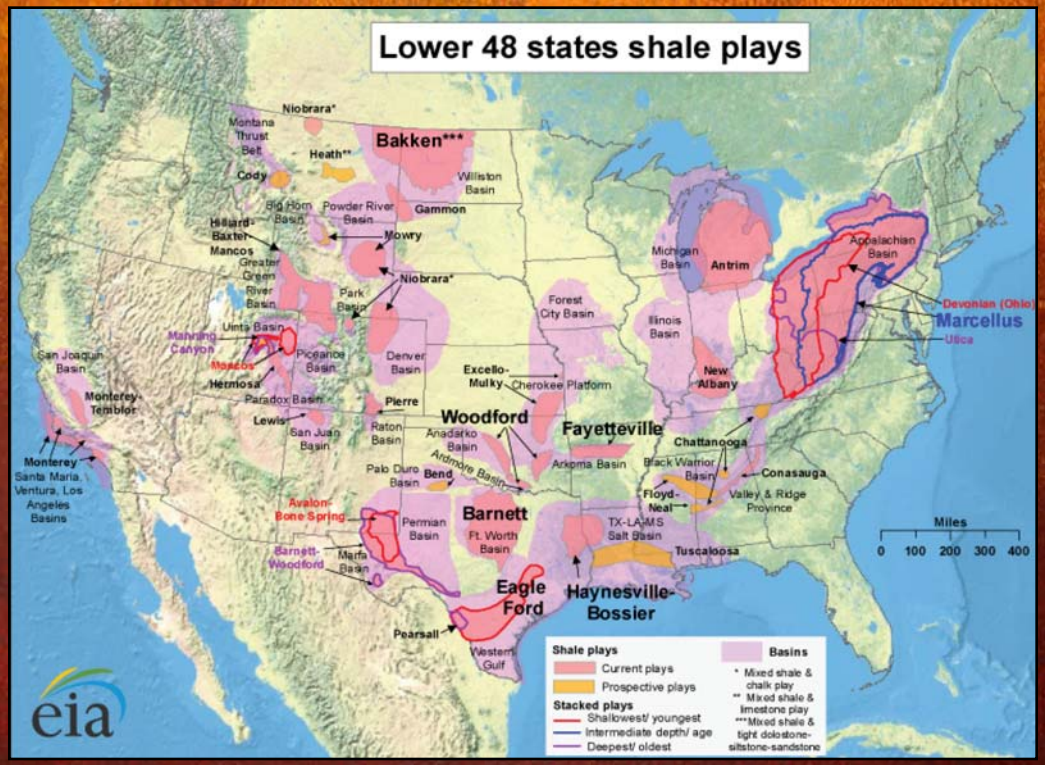
Drilling and producing from organic-rich shales represents a large paradigm shift for the oil-and-gas industry.

Prior to the late 1990s, these shales were thought of principally as the source of oil and gas. A small percentage of this petroleum would "leak" from the source beds and migrate into conventional reservoirs or *traps*. This small amount is what the world has produced for the last 150 years.



From Kostelnick (2010), modified from Schmoker and Oscarson (1995).

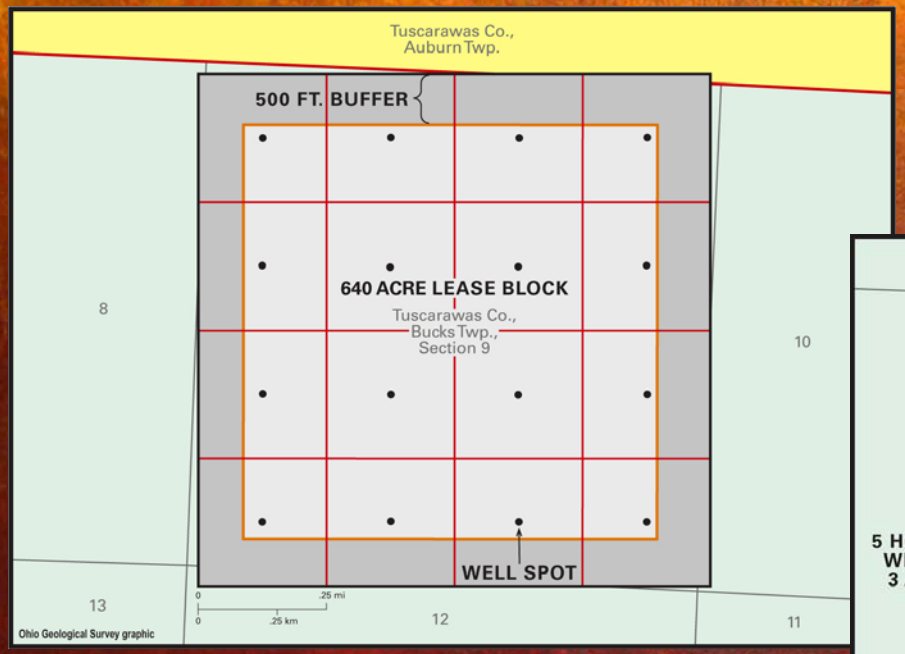
A Whole New Ballgame



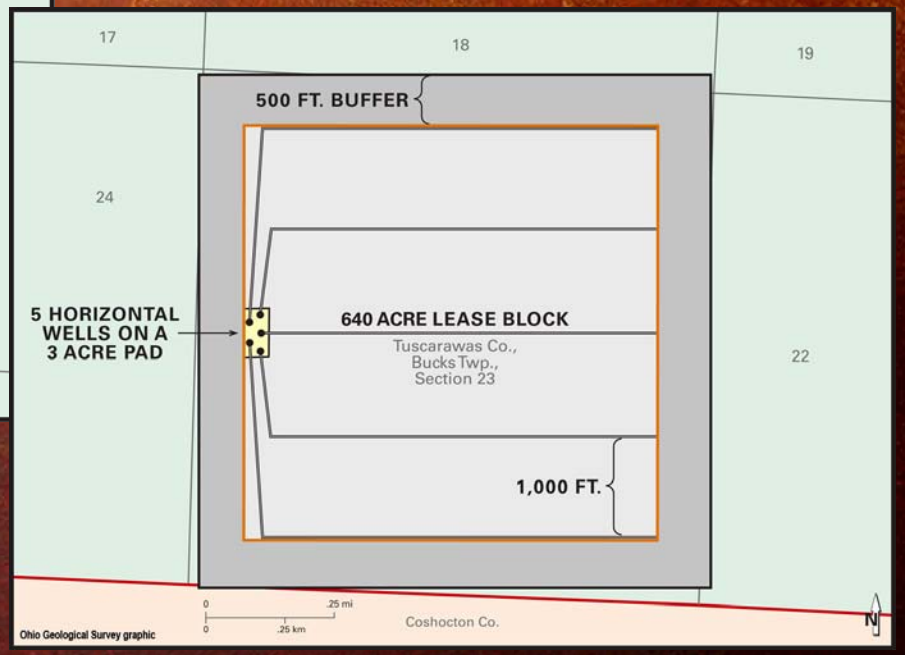
From EIA (2011).

The advent of drilling long, horizontal laterals combined with the ability to perform multiple-stage hydraulic fracture treatments has enabled the oil-and-gas industry to now produce from the source beds themselves, where >90% of the original reserves still reside. These technologies have allowed many shale gas plays to develop across the United States.

Developmental Drilling 101

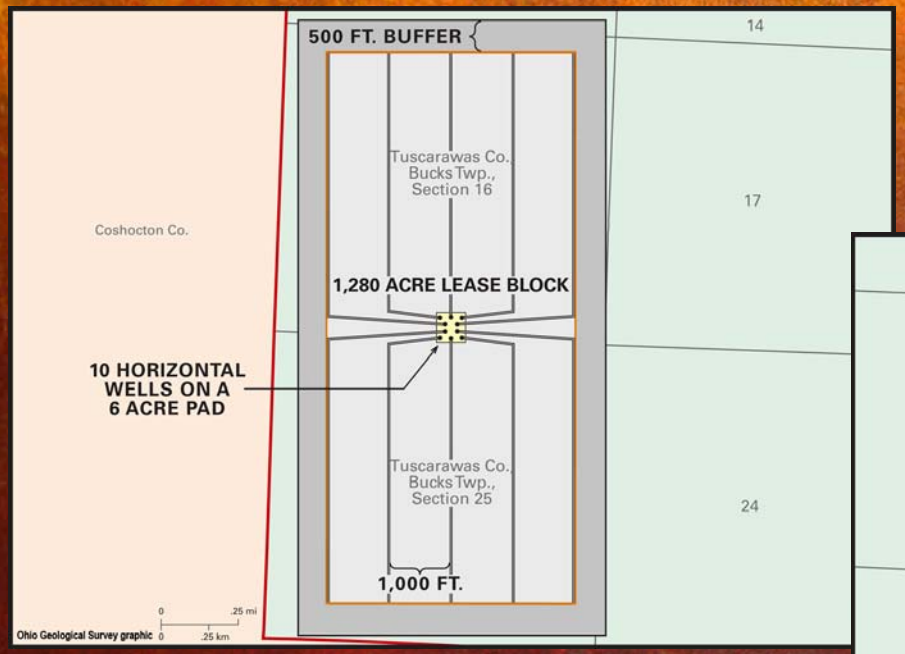


Previously, to develop a 1-square-mile lease block (640 acres) in Ohio would require 16 vertical wells, each with about 2-acre drill sites plus all the lease roads and pipelines.

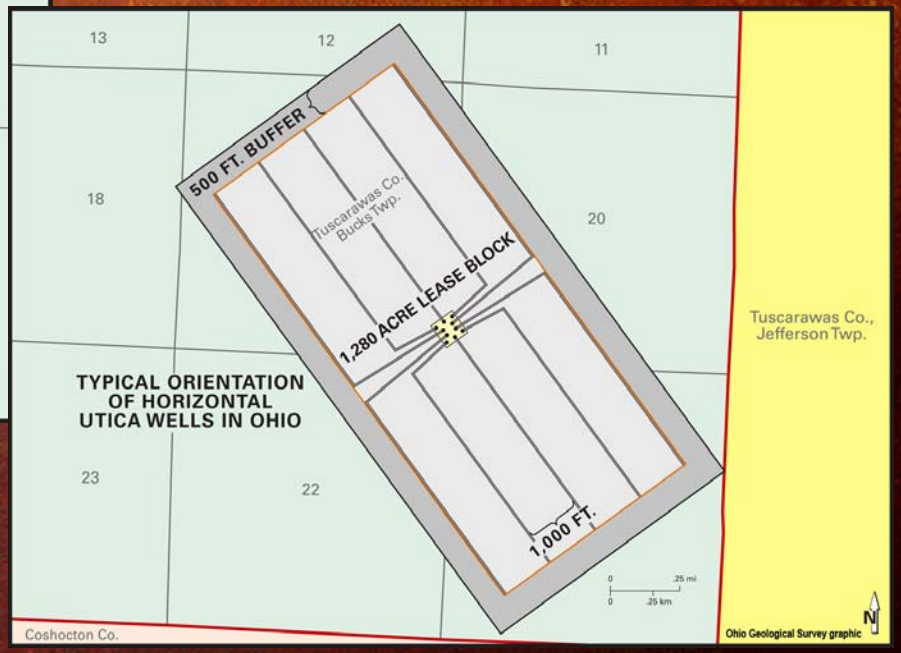


Today, using horizontal wells, this same square mile can be drained with 5-6 horizontal wells from a single 3- to 6-acre drill site.

Developmental Drilling 101 (cont'd)



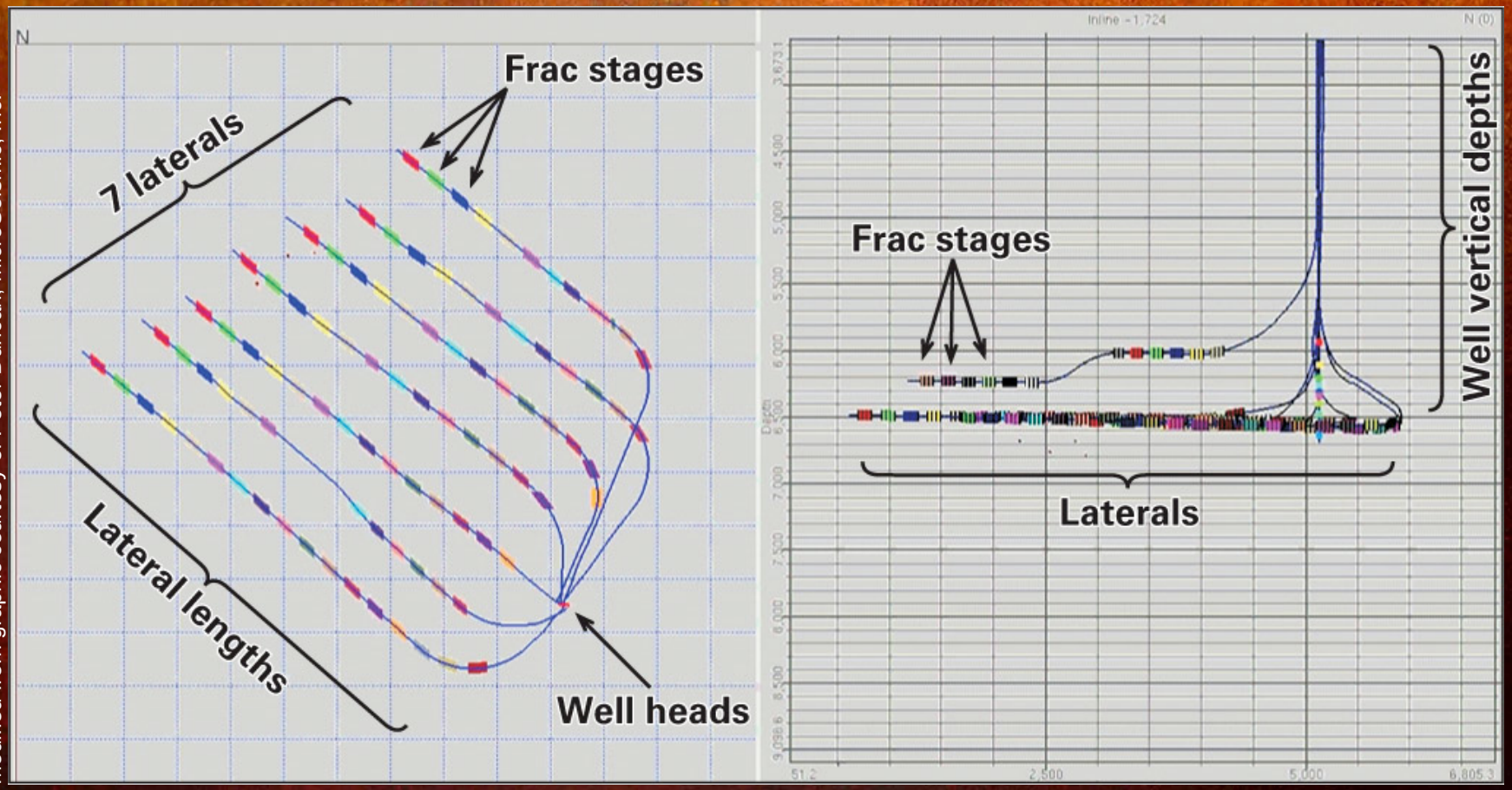
Optimally, operators would like to have lease blocks of about 2 square miles contiguous to allow drilling in two directions from one central drill pad.



Most horizontals are being drilled in a NW-SE orientation in Ohio to intersect the natural NE-SW joints and fractures.

Example layouts of 3-D Horizontal Wells

(example layouts)



Modified from graphic courtesy of Peter Duncan, MicroSeismic, Inc.

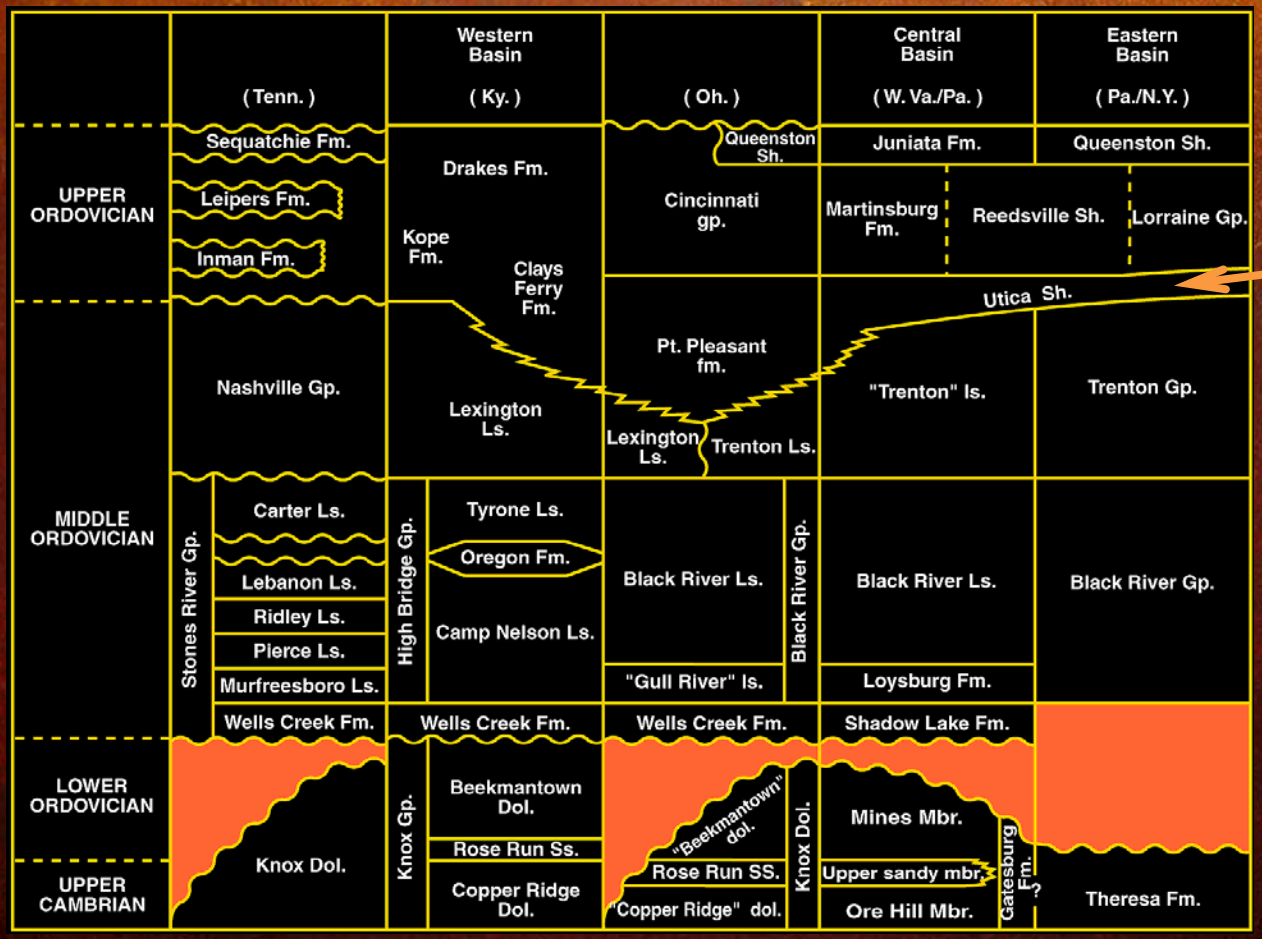
Plan View
(viewed from above)

Cross-sectional View
(viewed from the side)

Why Ohio and the Upper Ohio River Valley is the Focus of the Utica Play

- Ohio is favorable to drilling:
  - SB165 (2010) Strengthened regulatory program.
  - HB133 – Drilling on State lands.
  - Conducive and strong regulatory environment:
- Ohio has Underground Injection Control (UIC) primacy and adequate geologic capacity to store oilfield waste.
- Quebec, NY, and other states issued moratoriums.
- Generally shallower depths than other shale plays:
  - Drilling depths in Ohio ~3,500 to 10,000 feet.
- Interlayered carbonate and shale in Ohio – lends to "fracability" of the rock.
- Maturation levels, kerogen types, and drilling indicate more liquids and oil in Ohio.

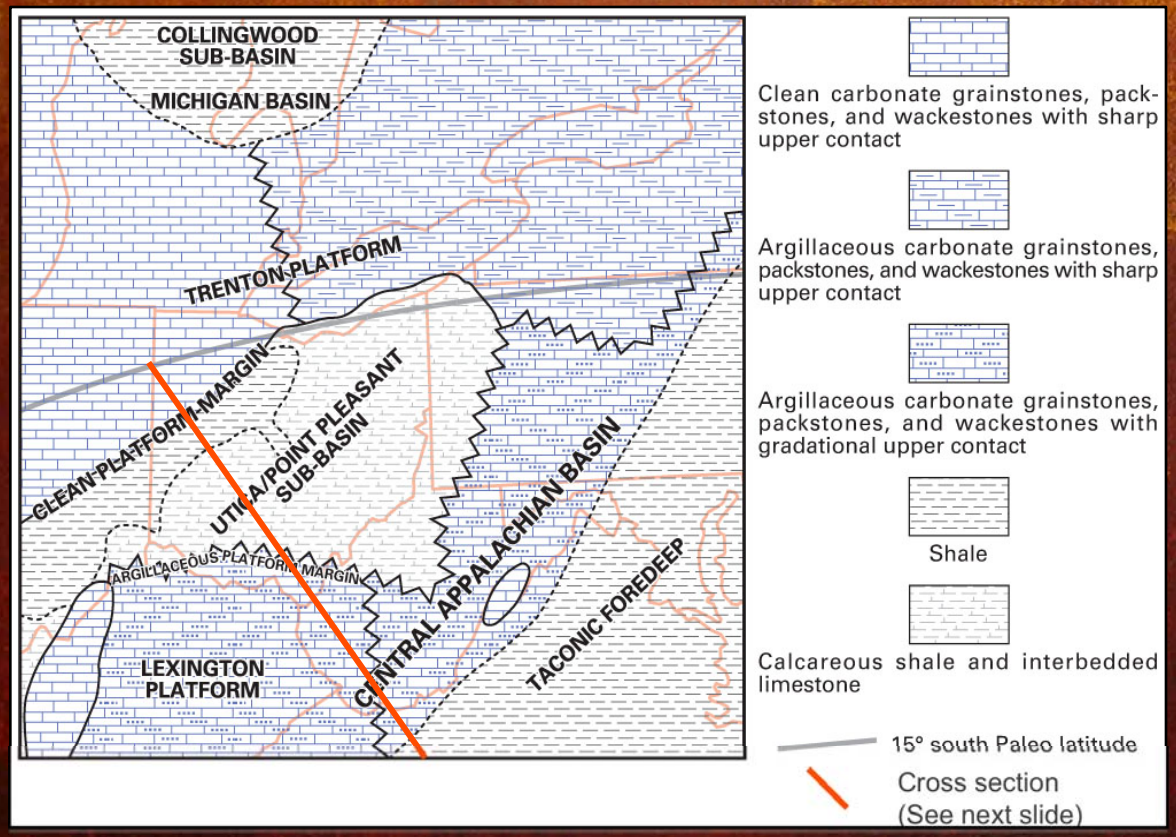
A Quick Look at the Utica-Point Pleasant Stratigraphy



From Wickstrom (1992).

The Point Pleasant is, in part, the lateral equivalent of the upper portion of the Trenton Limestone and is in a gradational relationship with the overlying Utica Shale, which thickens into the Appalachian Basin.

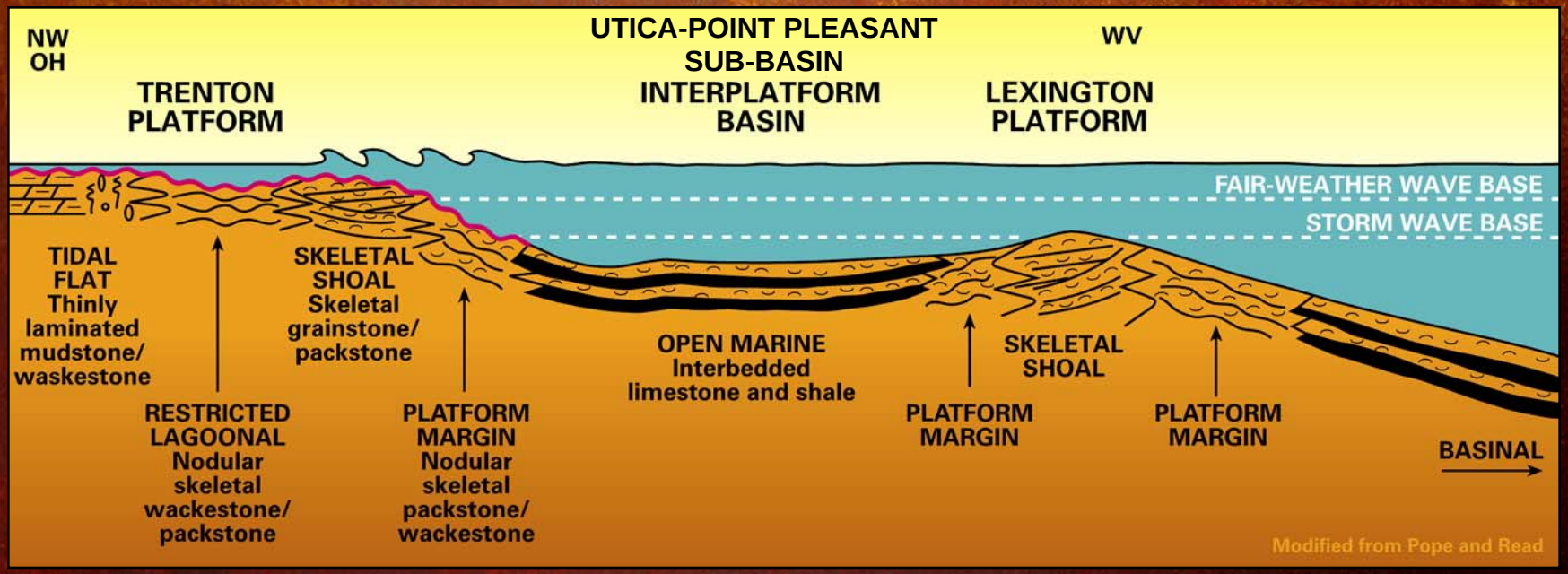
Facies Map of Trenton/Point Pleasant Time



Modified from Patchen and others (2006).

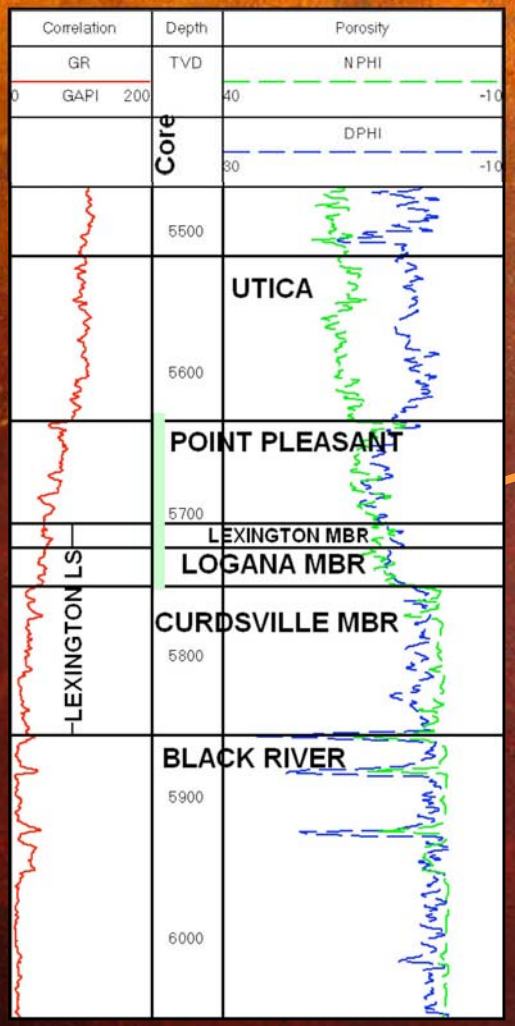
At the end of Trenton deposition time, the Point Pleasant was deposited within a restricted-circulation sub-basin, surrounded by carbonate platforms. As waters deepened, seas overrode the platforms, depositing the Utica Shale on top of the entire area.

Idealized Platform-to-Basin Model and Major Facies



Cross-sectional view of the interplatform sub-basin model.

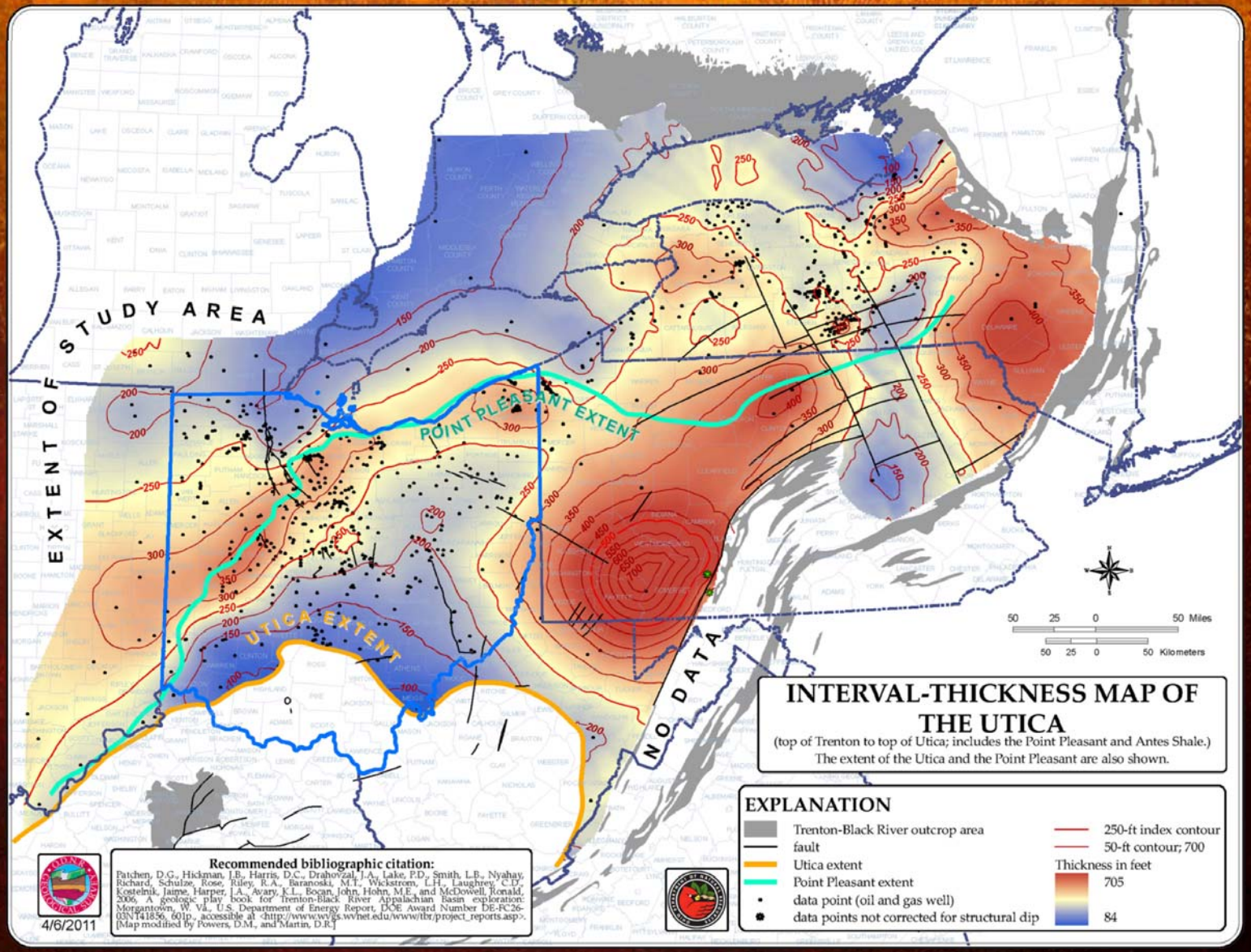
Point Pleasant Interval Log View and Actual Core



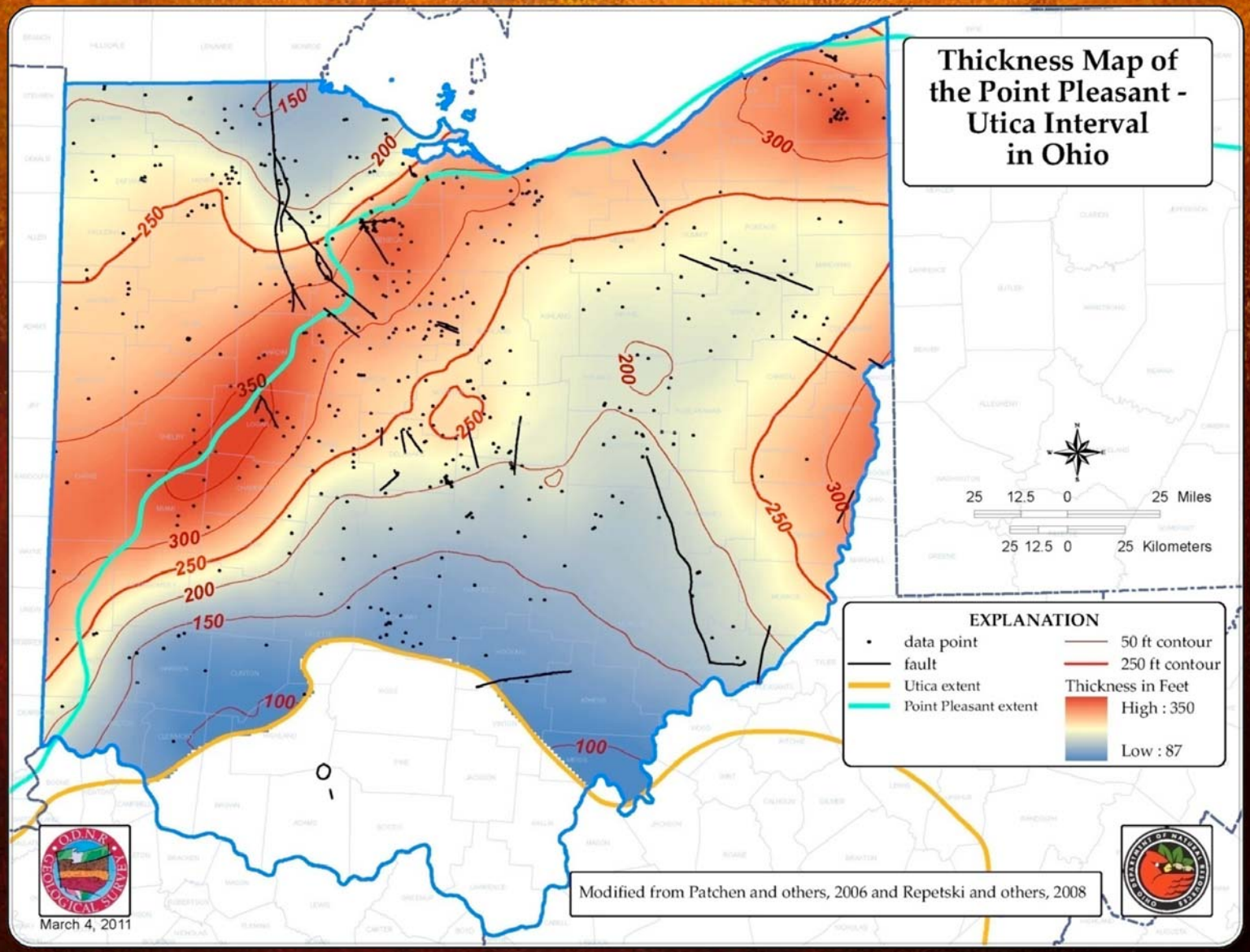
Coshocton County—#3 Barth Well
API NO 3403122838 (Core No. 3003)
5,660-5,670 feet

Geophysical log (left) and core photo illustrating the black, organic-rich nature and interlayered limestone & shale of the Point Pleasant.

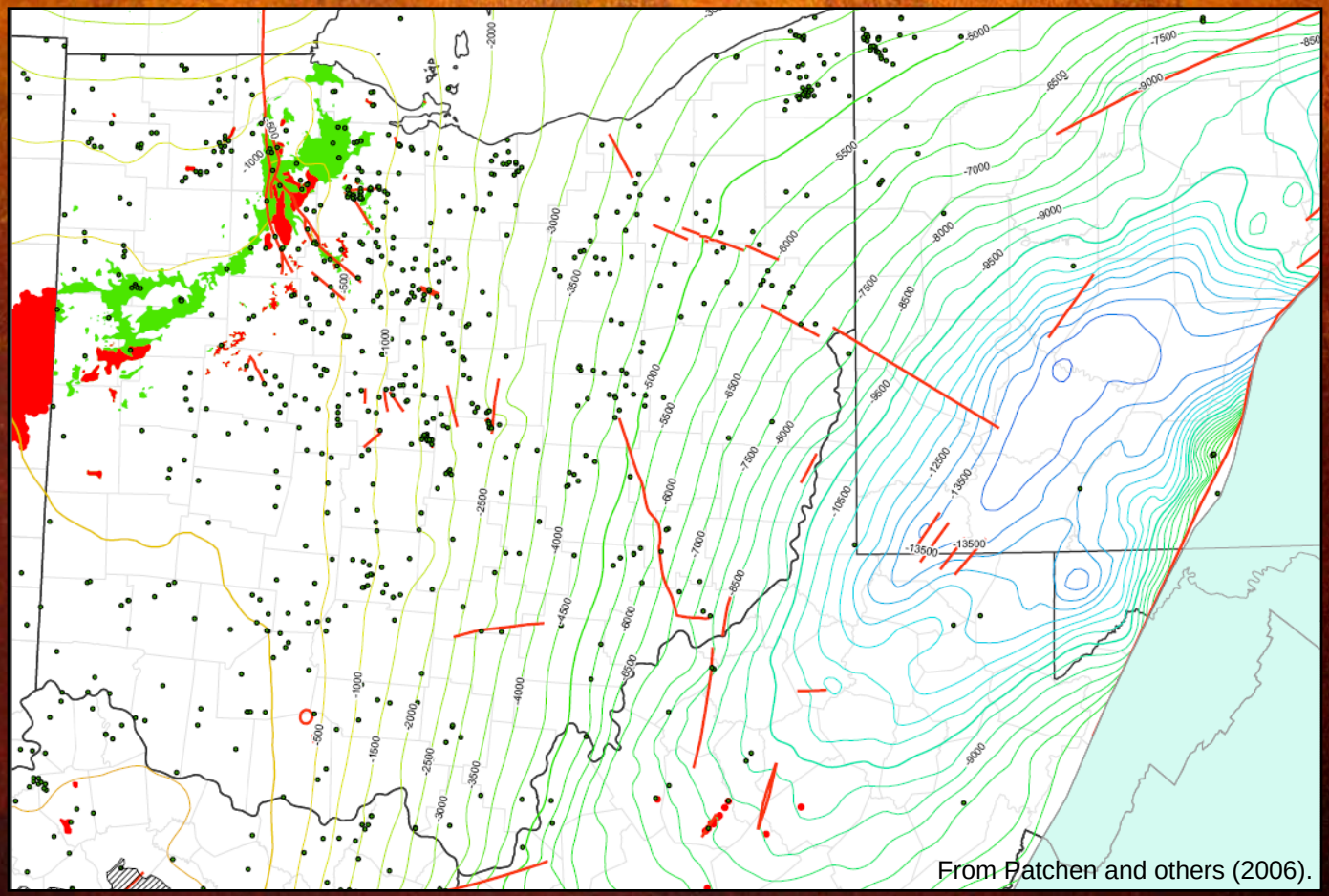
Regional Thickness Map of the Utica-Point Pleasant



Thickness of the Utica-Point Pleasant in Ohio

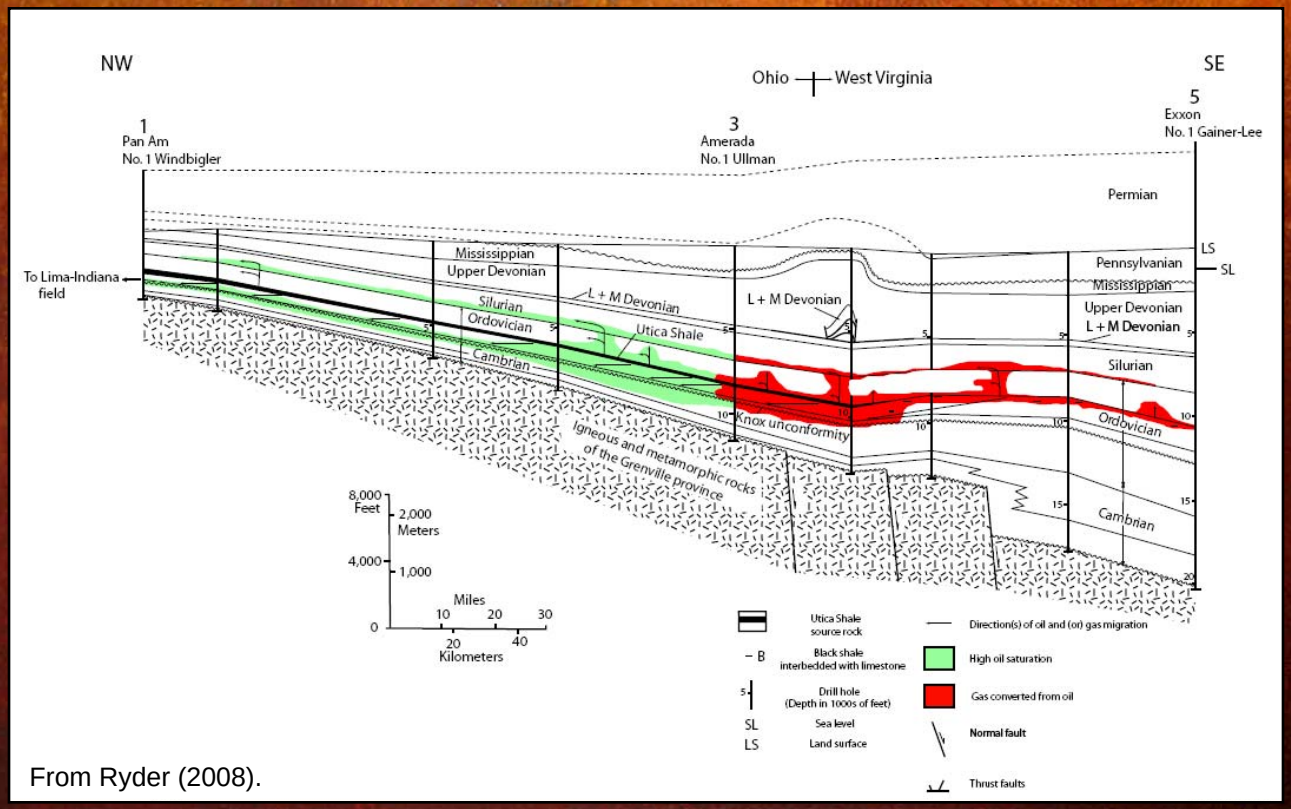


Trenton Structure Map



Structure drawn on top of the Trenton Limestone. Add topographic elevation to derive approximate drilling depths through the Utica-Point Pleasant interval.

Why Ohio may be the Focus of the Utica-Point Pleasant Play



From Ryder (2008).

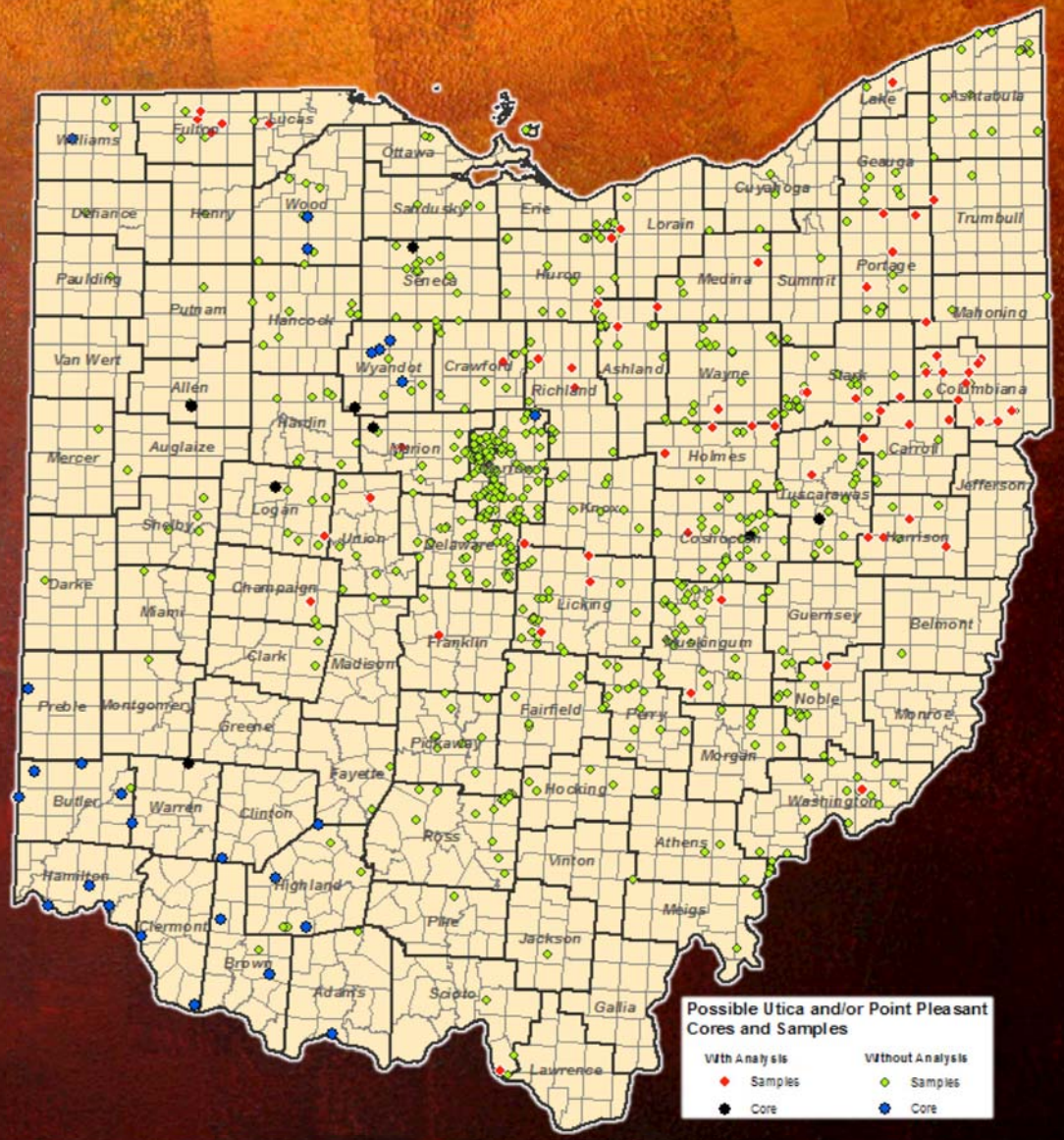
Gas-prone areas of Utica Shale will be in the deeper portion of the basin. Much of Ohio may contain appreciable amounts of oil within Utica wells, as shown in this NW–SE-oriented cross section illustrating the results of geochemical analyses of well samples.

Utica-Point Pleasant Cores and Cuttings

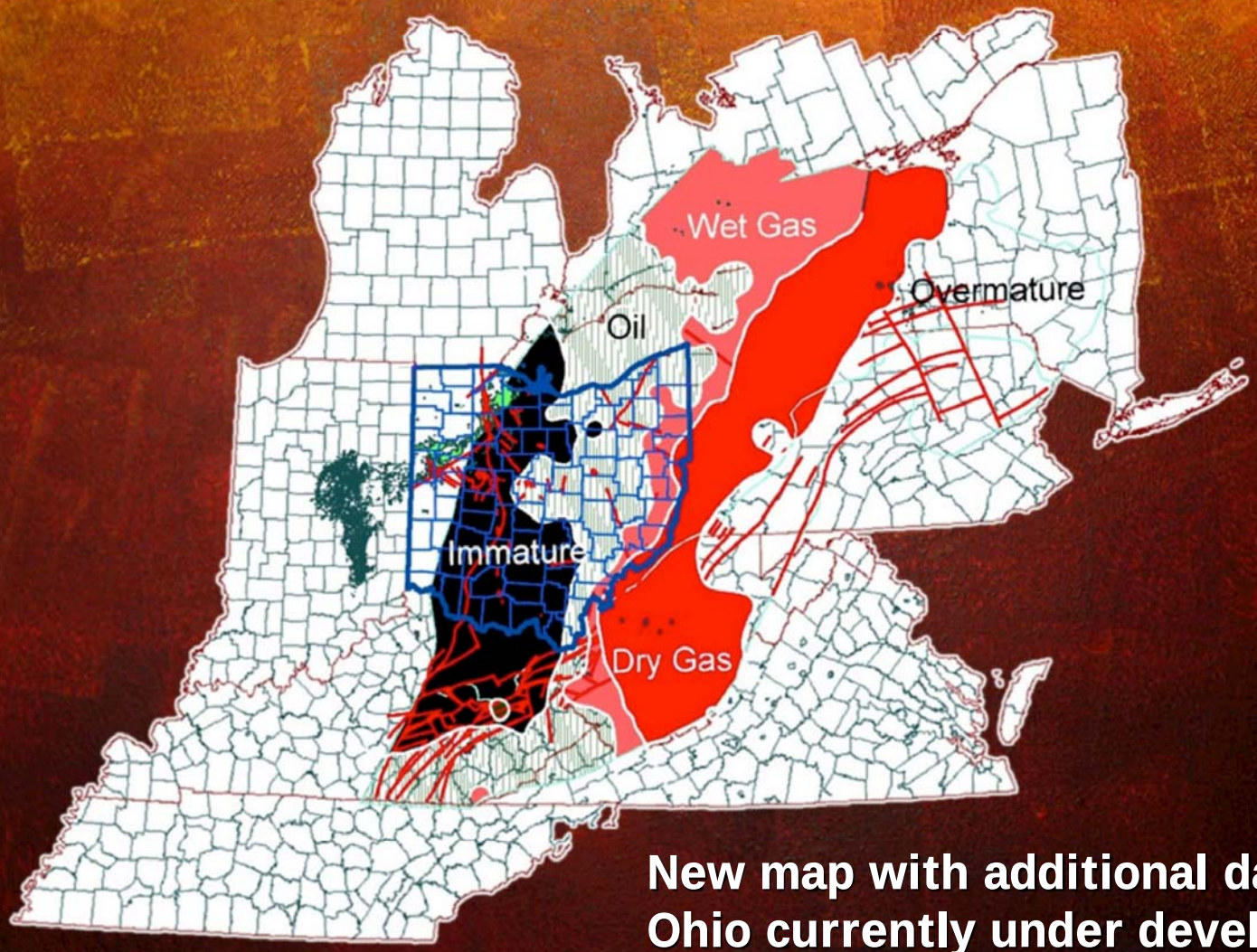
Recently, analyses by multiple companies have become public data. We are now starting to examine, interpret, and map this data.

We NEED operators to donate new core to our holdings for future use.

We can hold it CONFIDENTIAL for as long as necessary.



Levels of Maturation in the Utica-Point Pleasant Shale



New map with additional data for Ohio currently under development.

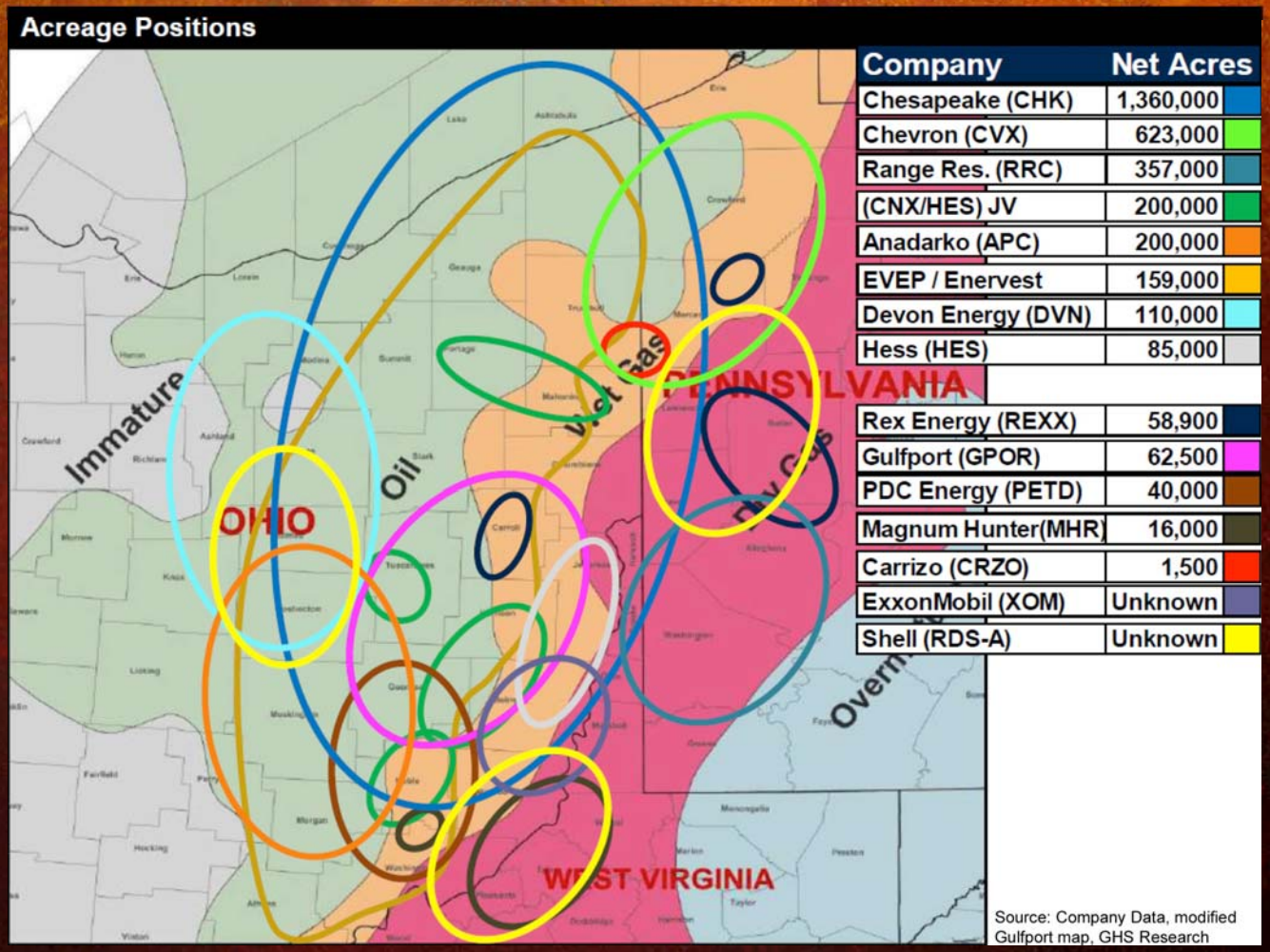
Modified from Patchen and others (2006).

Geochemical Analyses and Mapping Summary of the Utica-Point Pleasant Shale

- Organic content in eastern Ohio is very high.
- Organic matter is very rich and oil prone.
- Maturity levels created a range of dry gas in the east to oil in the central part of the state, a 100-mile span.
- Significant hydrocarbon generation has occurred across the area and the hydrocarbon content is quite high.
- The majority of the hydrocarbons are being generated in the Point Pleasant, but the overlying Utica is also prospective.
- The high carbonate content of the entire section suggests fracing could be very effective for production.

Reed, Brown, & Zumberge, November 2011, DUG East presentation

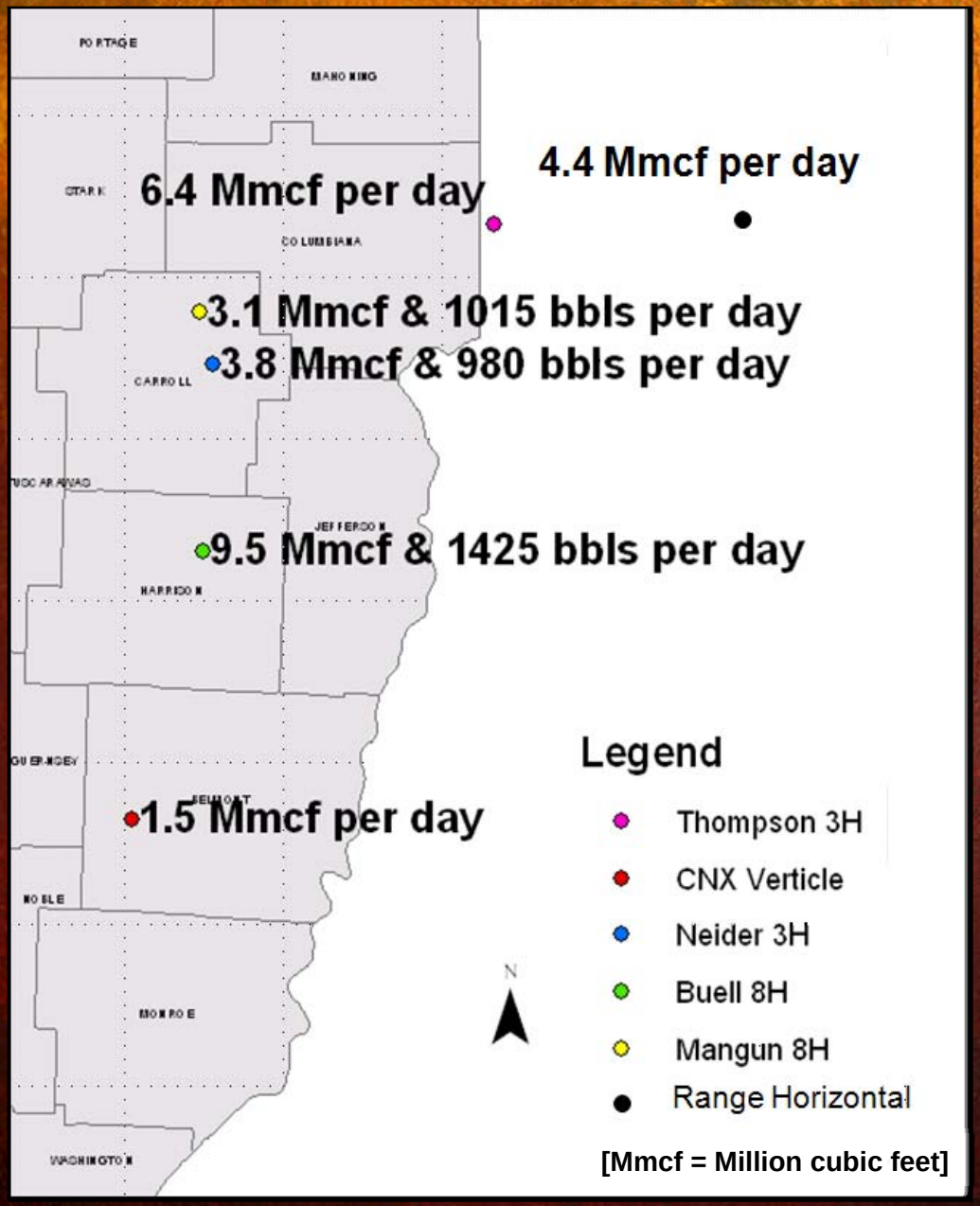
Acreage Positions of Various Energy & Petroleum Companies



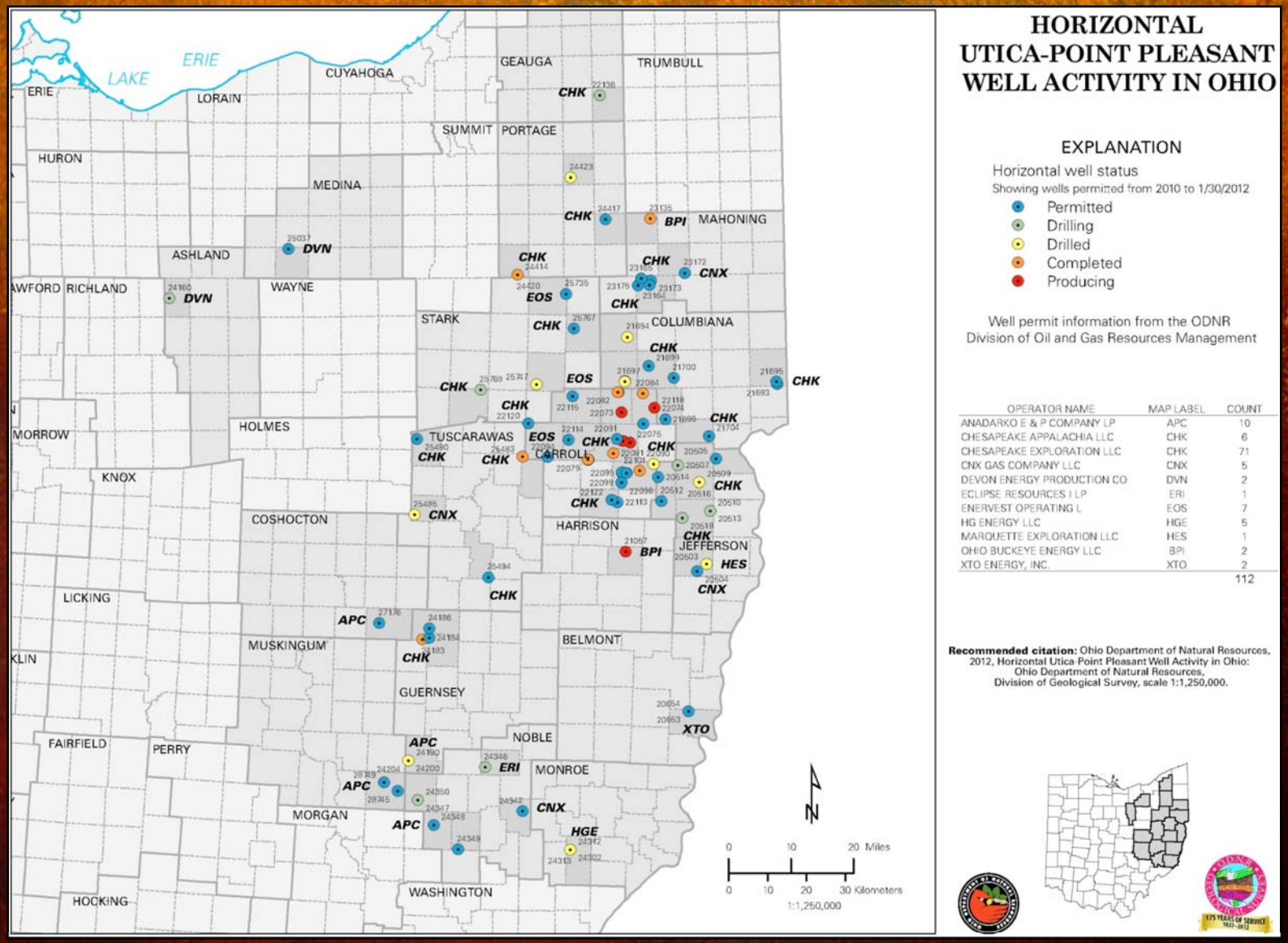
Company	Net Acres
Chesapeake (CHK)	1,360,000
Chevron (CVX)	623,000
Range Res. (RRC)	357,000
(CNX/HES) JV	200,000
Anadarko (APC)	200,000
EVEP / Enervest	159,000
Devon Energy (DVN)	110,000
Hess (HES)	85,000
Rex Energy (REXX)	58,900
Gulfport (GPOR)	62,500
PDC Energy (PETD)	40,000
Magnum Hunter(MHR)	16,000
Carrizo (CRZO)	1,500
ExxonMobil (XOM)	Unknown
Shell (RDS-A)	Unknown

Modified from M. Bodino, November 2011, DUG East presentation

Initial Production



- Range Resources drilled the first horizontal Utica well in the area and CNX drilled a vertical well in Belmont County, both in late 2010.
- Chesapeake wells reported via press release.



Activity map updated regularly and available at:

www.OhioGeology.com

A Word about Reserve Prediction

- One of the mandates of the Ohio Geological Survey is to "…collect, study, and interpret all available data pertaining to the origin, distribution, extent, use, and valuation of… natural resources such as… petroleum gas."
- Without actual production histories from existing Utica Shale wells, it is not possible to properly create a "probable" reserve estimate.
- Thus a volumetric reserve calculation must be used at this stage of the play. Such a calculation is full of assumptions and should be viewed only as an educated guess as to the ultimate recoverable reserves from the interval.
- The Ohio Geological Survey will continue to gather data and provide updated assessments when possible.

Volumetric Utica Oil Resource Assessment*

$$Q_t = V \times D \times TOC \times C \times \%R$$

Q_t = Quantity of hydrocarbons trapped (metric tons)

V = Volume of rock (cubic meters)

D = Rock density (kg/m)

TOC = Total organic content (percent)

C = Hydrocarbon conversion ratio (percent)

%R = Reservoir space with hydrocarbons (percent) (recoverable % from shale as reservoir)

1 metric ton = 7.1475 barrels

*Based on Wallace and Roen, 1989

Resource Assessment for the Utica-Point Pleasant in the Entire Appalachian Basin

$D = 2.65 \times 10^3$ kg/m

TOC = 1.34 percent

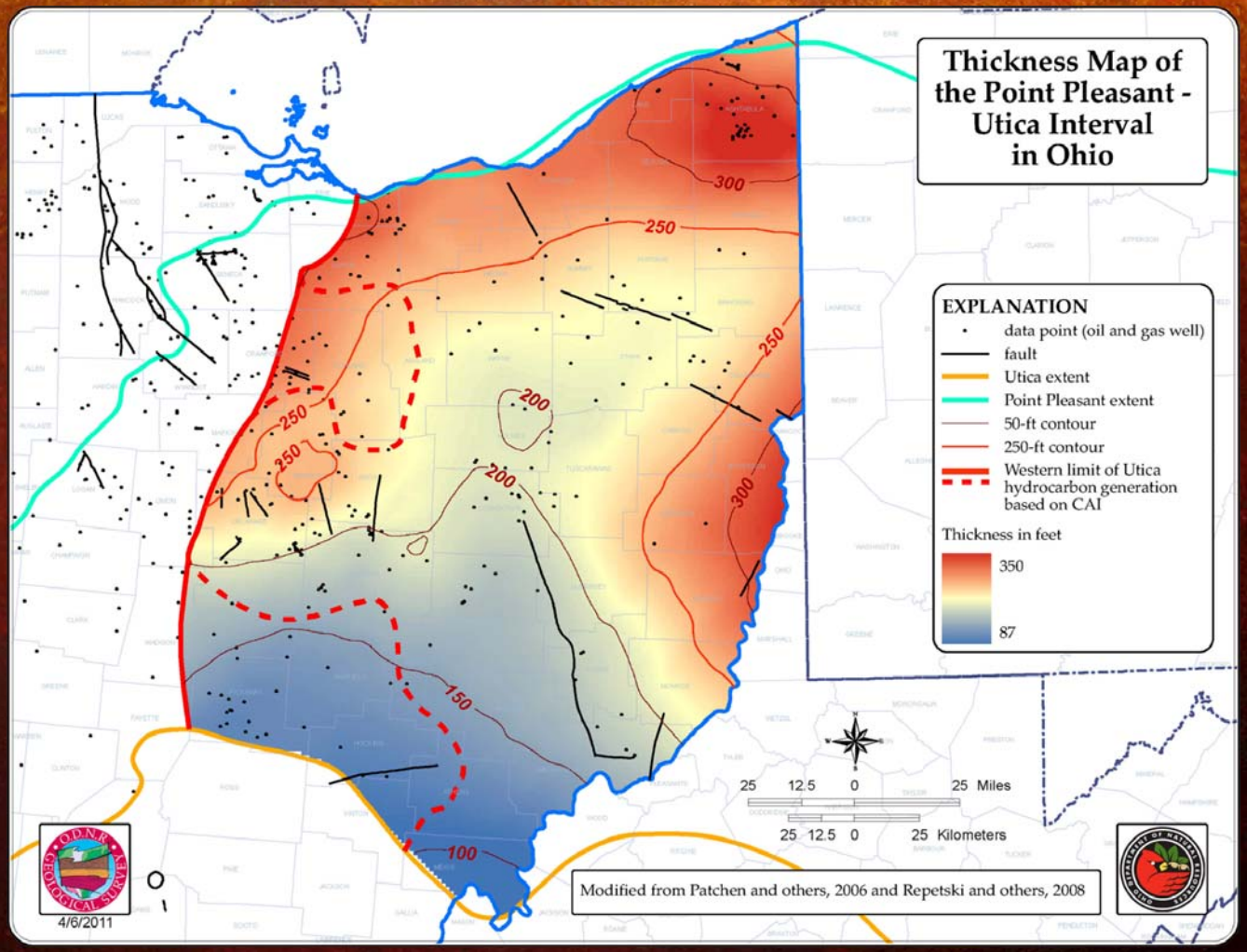
C = 10 percent

%R = 3 percent

Q_t = 13.26 billion barrels of oil migrated to conventional reservoirs

Wallace and Roen, 1989

Area of Greatest Utica Potential in Ohio (Used for Reserve Calculations)



Utica-Point Pleasant Recoverable Reserve Potential Estimate for Ohio

IF we assume $^1/_3$ of volume will be gas and $^2/_3$ is oil, then:

%R = 1.2 percent—recoverable from the interval
Q_t = 1.96 billion barrels equivalent
= 3.75 TCF gas and 1.31 billion barrels oil

%R = 5 percent—recoverable from the interval
Q_t = 8.2 billion barrels equivalent
= 15.7 TCF gas and 5.5 billion barrels oil

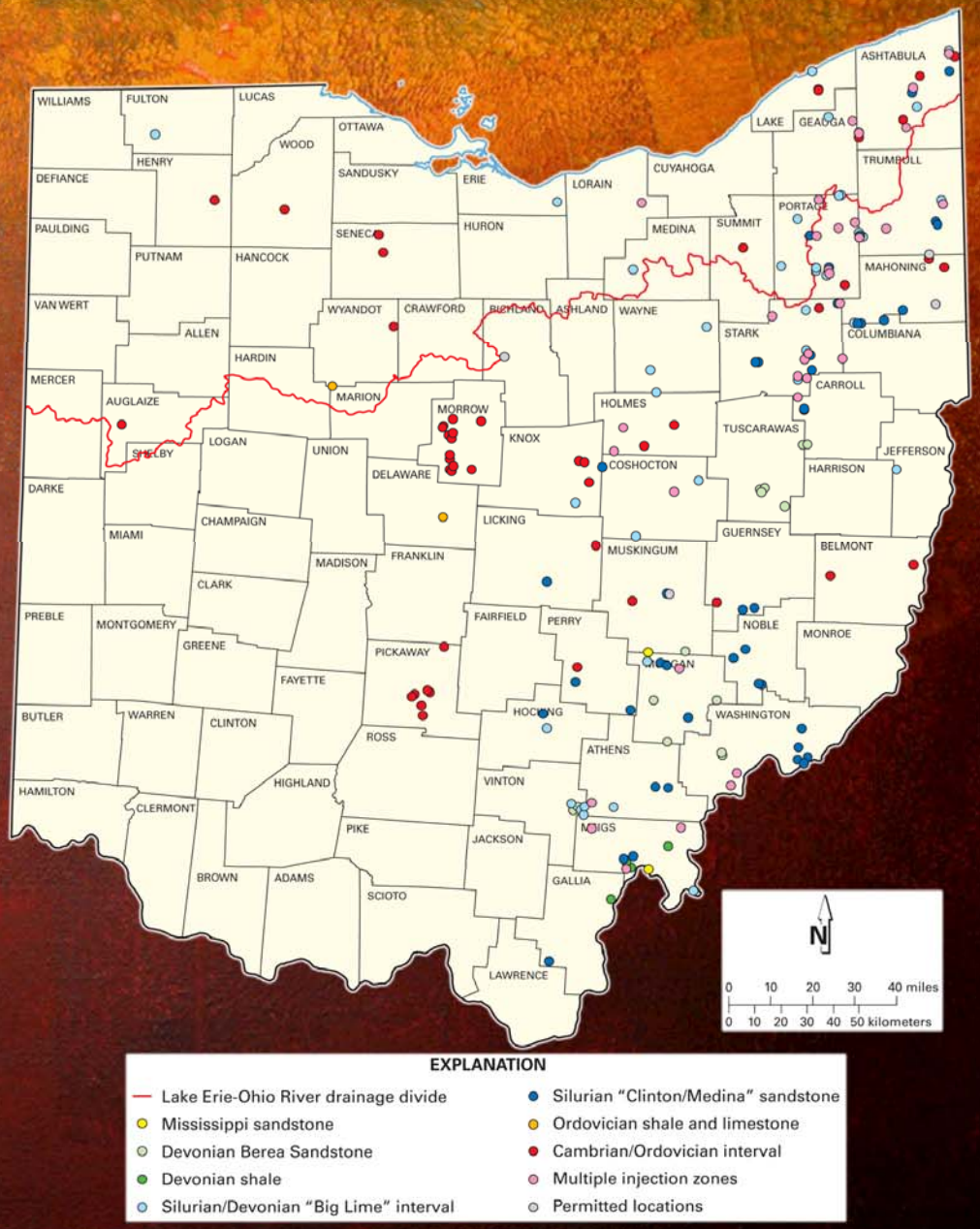
TCF = trillion cubic feet

Ohio Oil & Gas Laws, Regulations, and Policies

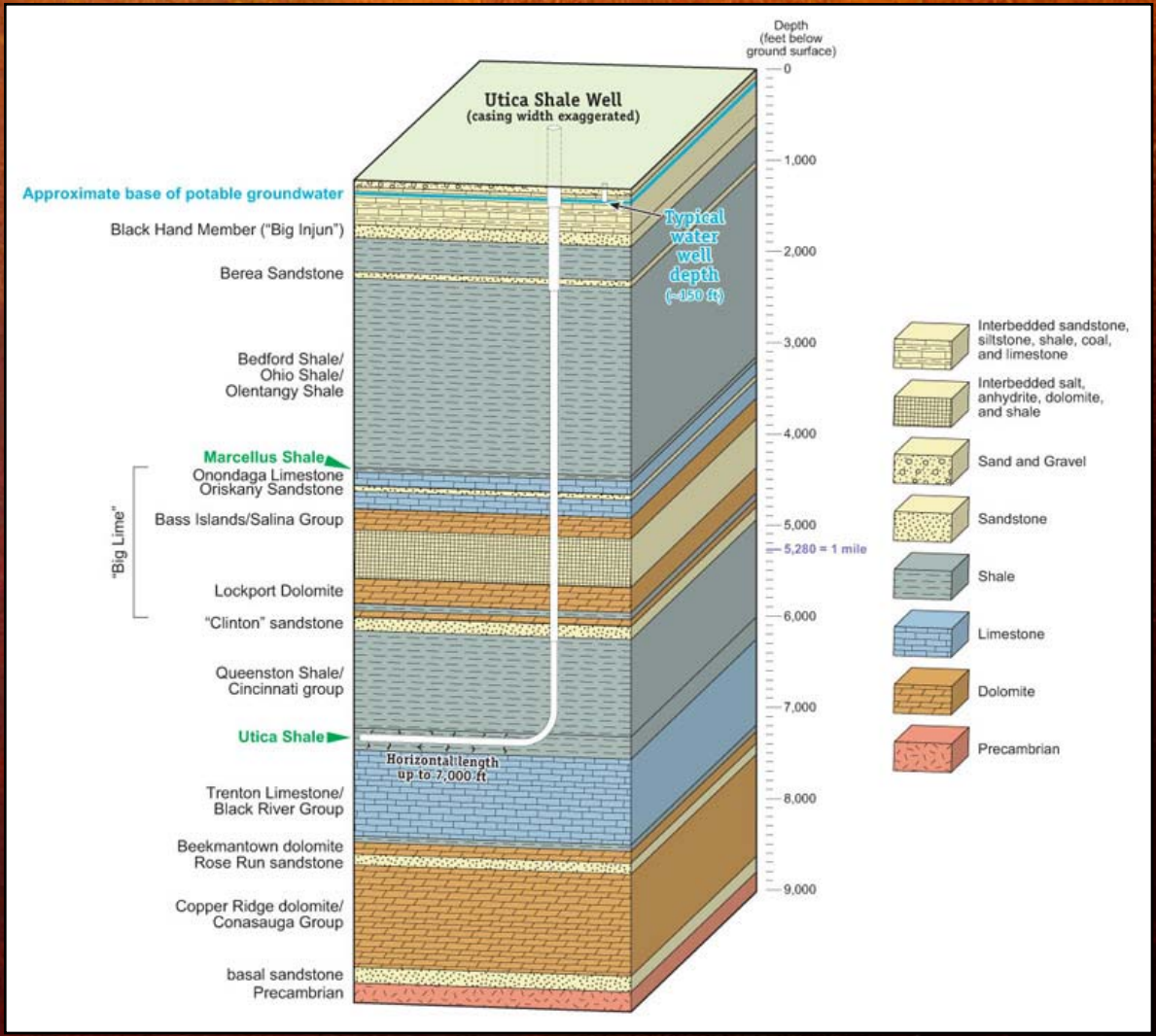
- ODNR Division of Oil & Gas Resources Management (sole and exclusive authority).
- Uniform statewide regulation: permitting, well locations, spacing, site construction, drilling, completions, production, restoration, and waste disposal.
- Conservation and effective development of oil & gas resources to prevent waste.
- Public health, safety, and environmental protection (compliance and enforcement).
- Idle and orphan well plugging program.
- UIC Class II brine disposal program.
- Ohio EPA has drafted a General Air Emissions Permit for the production operations of horizontal shale wells.

Salt Water Injection Well Location Map

- Ohio has regulatory primacy of its brine injection wells and adequate geologic capacity.
- New rules are being developed to further strengthen the program.



Generalized Geology and Profile of a Utica Shale Well Prototype in East-Central Ohio



At these depths, pressure from the overlying rocks and fluids make it physically impossible to induce a fracture all the way up to the groundwater layers.

"Wet" Gas

- Data and early drilling indicate much of the Utica-Point Pleasant production will be "wet" gas—that is natural gas (methane = CH_4) with a large percentage of associated natural gas liquids.
- Natural gas liquids (NGLs) can be differentiated by the number of hydrogen atoms they contain. For example, ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), and natural gasoline (C_5 and higher).
- Most gas production in Ohio previously has been relatively dry gas, which required little or no processing prior to being accepted into the gas pipeline system.

Select Physical Properties of Hydrocarbons Including Natural Gas Liquids

Compound	Formula	Molecular Mass	Boiling Point, ° C.	Density Air = 1	Compressibility
Methane	CH_4	16.04	-161.5	0.554	0.9981
Ethane	C_2H_6	30.07	-88.6	1.038	0.9915
Ethylene	C_2H_4	28.05	-103.8	0.9686	0.9938
Propane	C_3H_8	44.1	-42.1	1.5225	0.9810
Butane	C_4H_{10}	58.12	-0.5	2.0068	0.9641
Pentane	C_5H_{12}	72.15	36.1	2.4911	0.942
Hexane	C_6H_{14}	86.18	68.7	2.9753	0.91
Heptane	C_7H_{16}	100.21	98.4	3.4596	0.852

Modified from Lyons and Plisga (2005).

NGLs Add Value

- Historically, the price of a barrel of NGLs has tracked the price of crude oil more closely than the price of natural gas (although NGLs as a whole track at about 60% the price of crude oil) .
- When gas prices are low relative to oil—a condition that prevails today—the sale of NGLs produced from gas can offer a meaningful boost to profitability.
- When natural gas prices are high relative to the price of NGLs, it is less profitable to process natural gas because of the higher value and the increased cost of separating the NGLs.

Processing and Fractionation

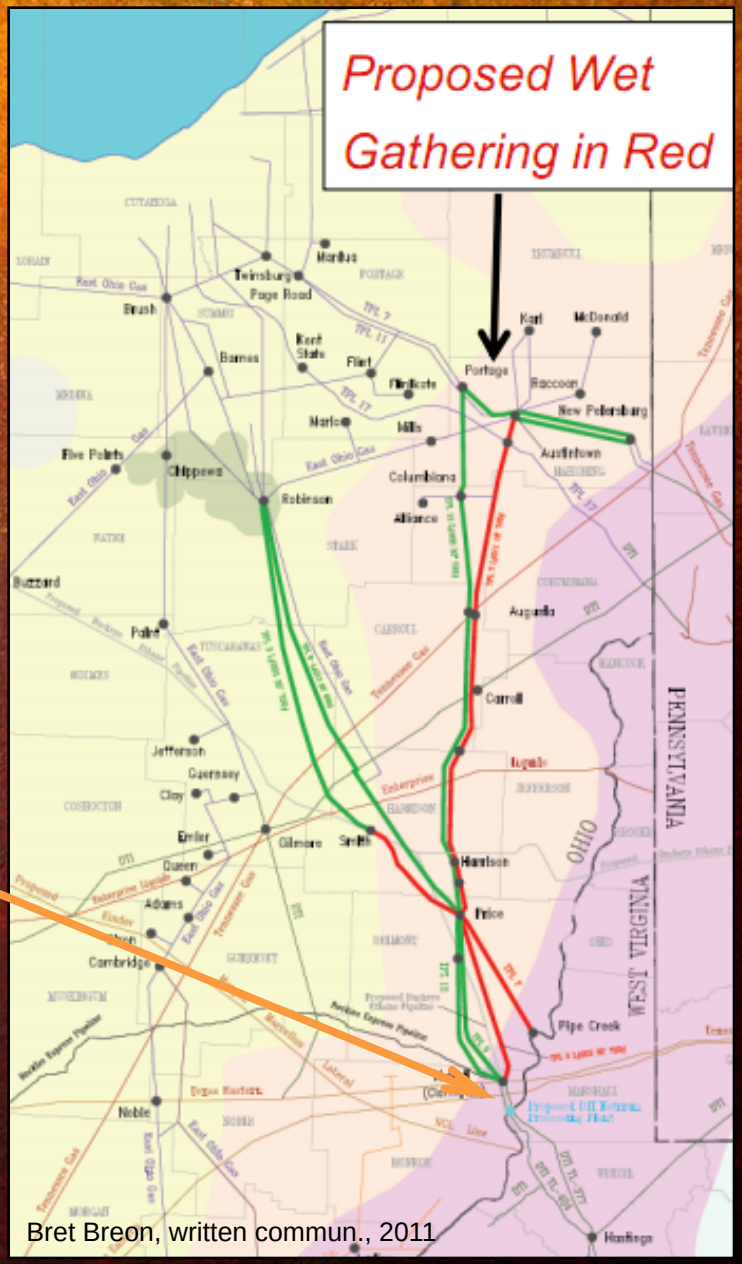
- Natural gas processing involves the removal of impurities and NGLs from raw gas, while fractionation involves the separation of the NGL stream into distinct hydrocarbons.
- Both may be great economic opportunities for Ohio in the early years of Utica-Point Pleasant production as very little processing capability and no fractionation plants exist in Ohio.

Collection Pipelines

Dominion and NiSource are both converting portions of their large transmission lines to accept wet gas for the short term, while additional processing and fractionation plants are built.

Natrium Processing Plant under development (Dec. 2012) to handle 200 MMCFGD and fractionate 36,000 bbl NGL—may expand to 400 MM and 59,000 bbl.

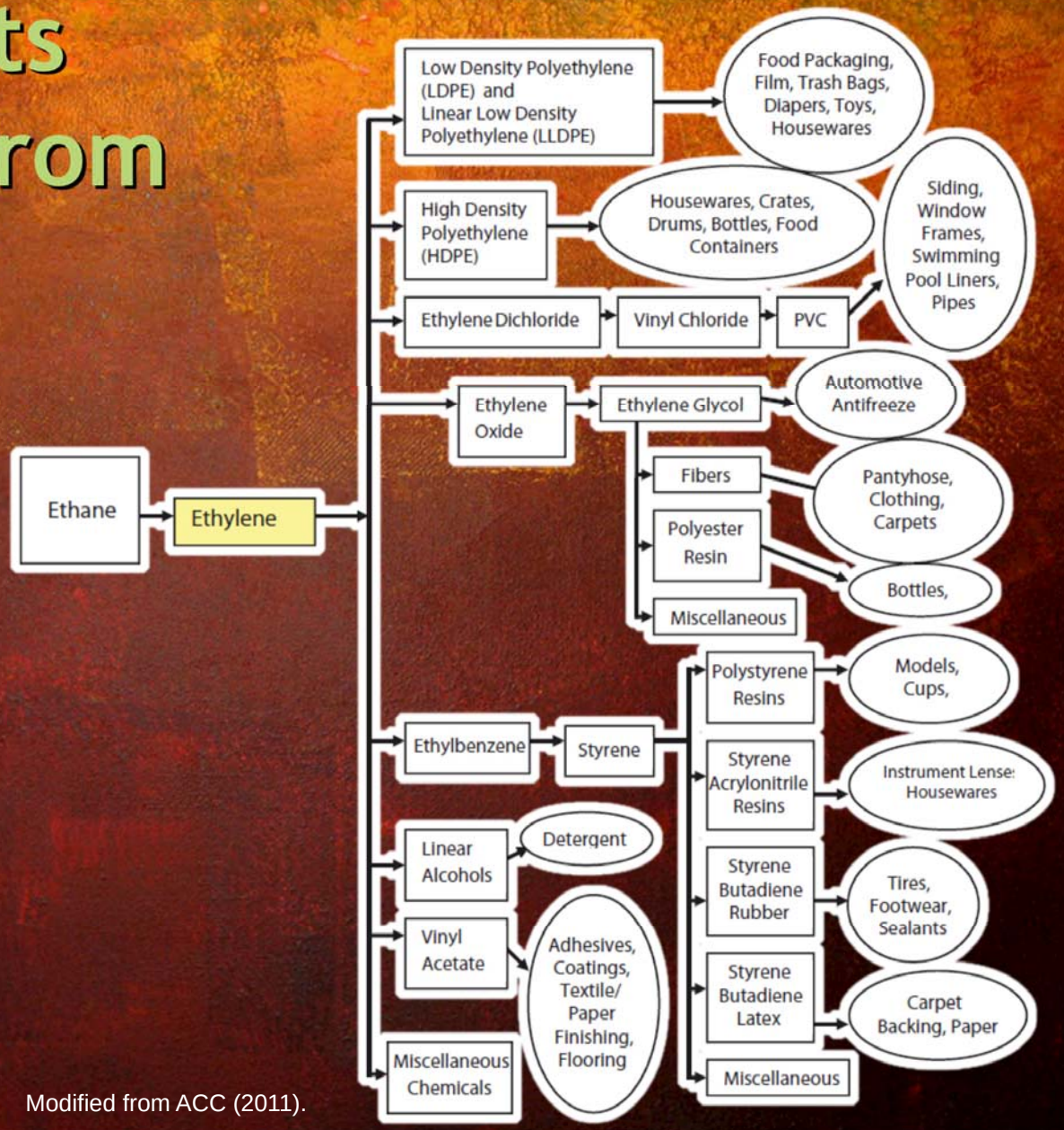
MMCFGD = Million cubic feet of gas per day
Bbl = Barrels



Bret Breon, written commun., 2011

Products Created from NGLs

Simplified flow chart illustrating the ethylene supply chain from ethane feedstock through petrochemical intermediates and final end use products.

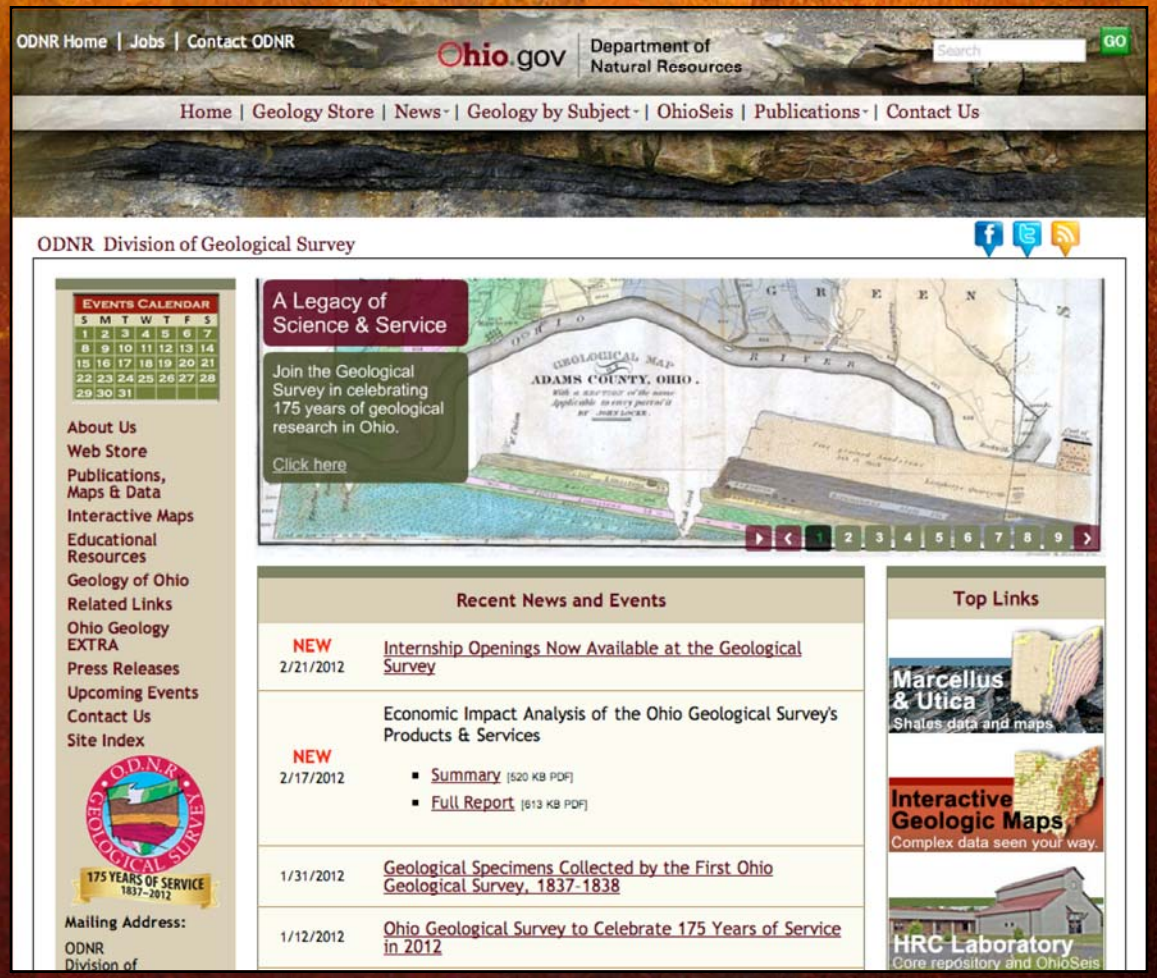


Modified from ACC (2011).

Petrochemical Products—Our Society is Built on Them

Photo courtesy National Geographic and OOGEEP.

www.OhioGeology.com



The Ohio Geological Survey is continually posting new information on the shale plays on its website.

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Further Reading

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